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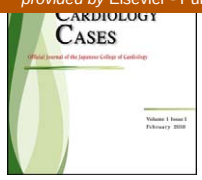

Case Report

Endovascular management of subclavian artery stenosis using balloon expandable covered stents

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KEYWORDS
Subclavian artery stenosis;
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Endovascular intervention

Summary Covered stents have primarily been used in coronary arteries for exclusion of perforations, aneurysms, and fistulas. The use of covered stents to treat occlusive disease of first-order aortic branches has been proposed as a method to reduce intimal hyperplasia and improve patency rates, since they exclude plaque and prevent luminal encroachment through open struts, but their selective use in subclavian artery stenosis has not been previously reported. We present three cases of subclavian artery stenosis that were successfully treated via a percutaneous approach with covered stents.

Introduction

Covered stents (CS) consist of a metallic stent skeleton covered with synthetic graft material and have primarily been used in the coronary arteries for exclusion of perforations, aneurysms, and fistulas [1]. The use of CS to treat occlusive disease of first-order aortic branches has been proposed as a method to reduce intimal hyperplasia and improve patency rates [2] since they exclude plaque and prevent luminal encroachment through open struts, but their selective use in subclavian artery stenosis has not been previously reported. We present three cases of subclavian artery stenosis that were successfully treated via a percutaneous approach with CS.

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Case 1

A 69-year-old Hispanic male with history of hypertension and chronic obstructive pulmonary disease secondary to tobacco use presented with shortness of breath and dizziness with use of his left upper extremity over the course of two months. Physical examination was remarkable for unequal blood pressures measuring peak systolic 166 mmHg in the right arm and 132 mmHg in the left arm and diminished left radial pulse. Laboratory analysis revealed brain natriuretic peptide within normal limits at 37 pg/ml. Further noninvasive diagnostic testing was performed: electrocardiogram showed sinus rhythm with occasional premature ventricular complexes and nonspecific ST-segment changes; transthoracic echocardiography revealed dilated left ventricular cavity, severely depressed function with an estimated ejection fraction of 30% and global hypokinesis. Coronary angiography was performed to exclude coronary artery disease as the etiology of cardiomyopathy, which only demonstrated mild single vessel atherosclerosis. Arch aortography (Fig. 1a) and selective

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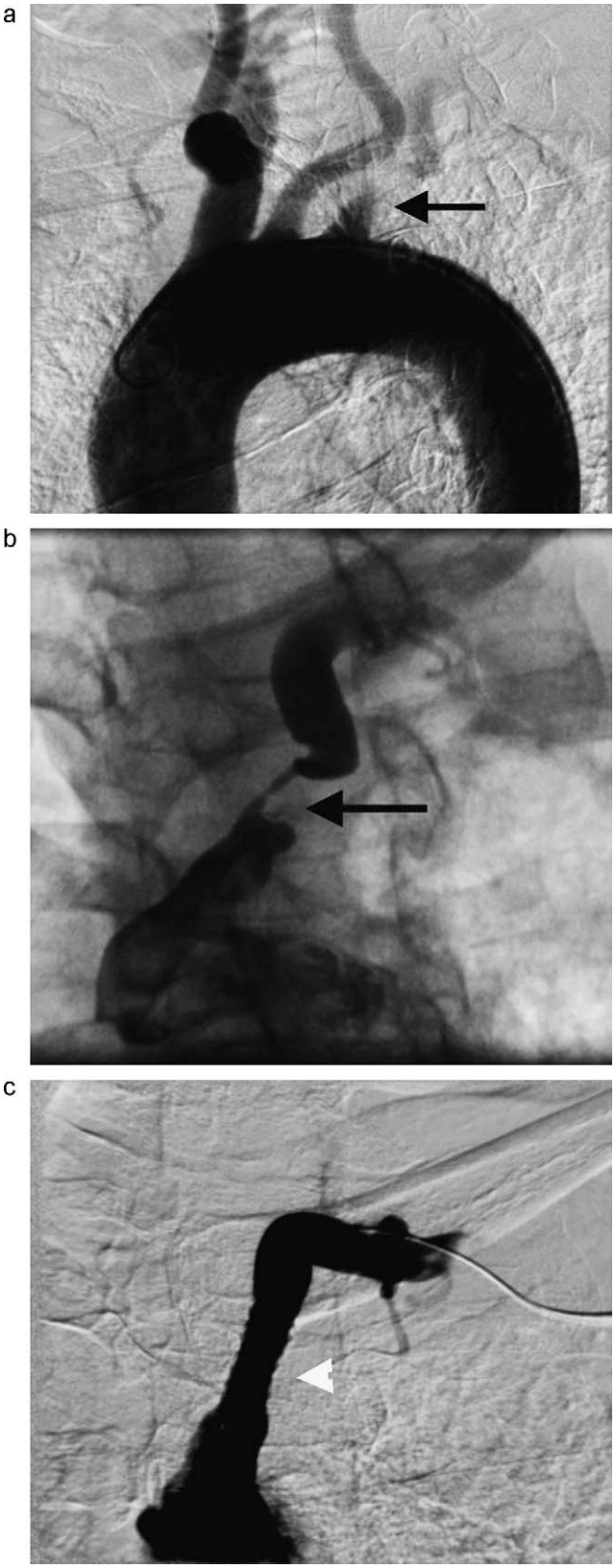

Figure 1 Arch aortography (a) and selective arteriography (b) demonstrating a 90% tubular lesion (arrow) in the proximal left subclavian artery and a good angiographic result (c) after angioplasty and stent (arrowhead).

arteriography of the left subclavian artery (Fig. 1b) revealed a 90% tubular stenosis in the proximal vessel with retrograde filling of the distal vessel from the left vertebral artery. Decision was made to intervene on the left subclavian artery as the culprit lesion in the setting of symptoms of subclavian steal syndrome. A 7 French 90 cm Shuttle sheath (Cook, Bloomington, IN, USA) was used to cannulate the vessel and the lesion crossed using a 0.035 inch 180 cm Aquatrack wire (Cordis, Miami Lakes, FL, USA). Balloon angioplasty was performed using a 7×20 mm Powerflex balloon (Cordis) with 1 inflation at 10 atmospheres. An iCAST 7×22 mm CS (Atrium Medical, Hudson, NH, USA) was deployed with 1 inflation at 10 atmospheres followed by post-dilatation using a 9×20 mm Powerflex balloon with 1 inflation at 10 atmospheres with good angiographic result (Fig. 1c) and no residual gradient. The patient was discharged home in stable condition the following day after optimization of his heart failure therapy.

Case 2

A 70-year-old Caucasian female with a history of hypertension and chronic obstructive pulmonary disease secondary to tobacco use presented with progressive exertional angina and dyspnea over the course of six months. Physical examination findings were remarkable for absent pulses in the left upper extremity and inability to measure blood pressure in the left arm. Laboratory analysis was unremarkable with negative cardiac biomarkers. Further diagnostic testing was noncontributory: electrocardiogram showed sinus bradycardia without ST-segment changes; transthoracic echocardiography revealed low normal left ventricular function with an estimated ejection fraction of 50% and no wall motion abnormalities. Coronary angiography demonstrated multivessel coronary artery disease. Arch aortography (Fig. 2a) and selective arteriography were performed to assess patency of left subclavian artery and suitability of left internal mammary artery as a graft for coronary artery bypass grafting (CABG) and showed an 80% stenosis at the ostium with a measured resting gradient of 20 mmHg. After consultation with cardiothoracic surgery for CABG, the patient was brought back to the catheterization laboratory five days later for angioplasty of the left subclavian artery. A 7 French 90 cm Shuttle sheath was used to cannulate the vessel and the lesion crossed using a 0.035 inch 180 cm Aquatrack wire. Balloon angioplasty was performed using a 7×20 mm Powerflex balloon with 1 inflation at 10 atmospheres. An iCAST 7×22 mm CS was deployed with 1 inflation at 12 atmospheres with a good angiographic result (Fig. 2b) and no residual gradient. The patient was discharged home in a stable condition the following day with plans for elective CABG as an outpatient.

Case 3

A 67-year-old Caucasian female, with history of coronary artery disease and CABG seven years prior, presented with substernal chest pressure with exertion over the course of two months. Physical examination revealed unequal blood pressures measuring peak systolic 195 mmHg in the right arm and 95 mmHg in the left arm and diminished pulse in the left

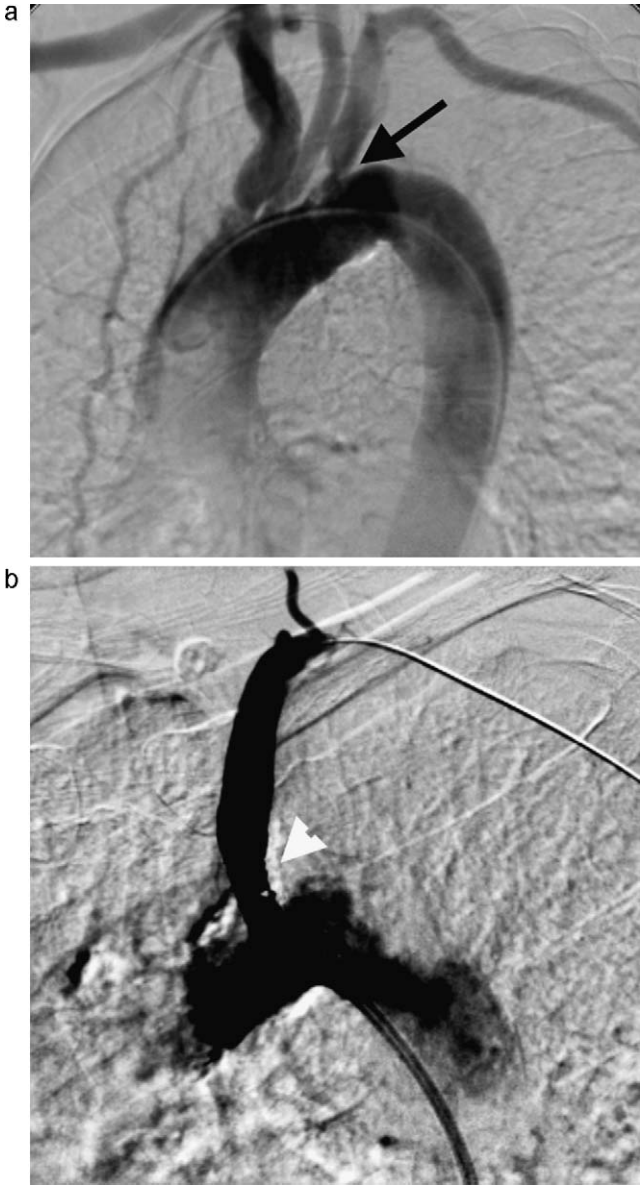

Figure 2 Arch aortography (a) demonstrating an 80% discrete lesion (arrow) at the ostium of the left subclavian artery and a good angiographic result (b) after angioplasty and stent (arrowhead).

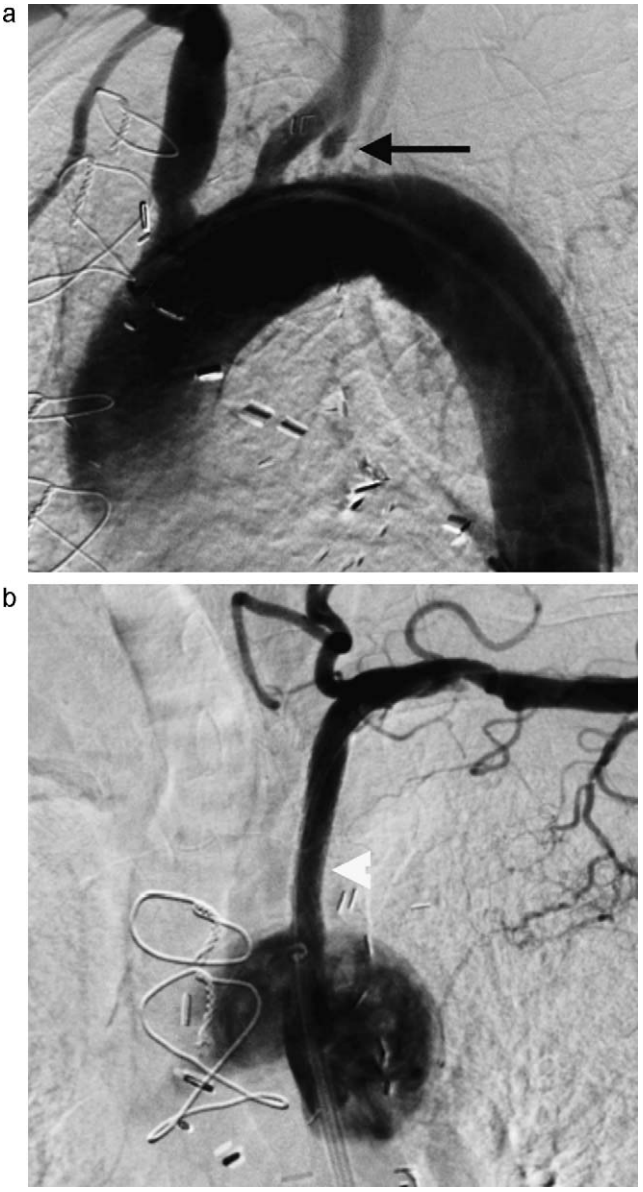

Figure 3 Arch aortography (a) demonstrating an 80% lesion (arrow) at the ostium of the left subclavian artery and a good angiographic result (b) after angioplasty and stent (arrowhead).

radial artery. Laboratory analysis was unremarkable with normal renal function. Further noninvasive diagnostic testing was performed: electrocardiogram showed normal sinus rhythm with left axis deviation and nonspecific ST-segment changes; echocardiogram showed normal left ventricular function with no regional wall motion abnormalities; exercise single photon emission computed tomography (SPECT) demonstrated a large reversible defect involving the anterior apical myocardium after Stage I of a modified Bruce protocol. Subsequent coronary angiography revealed severe native coronary artery disease and moderate ectasia and degeneration of the saphenous vein grafts. Arch aortography (Fig. 3a) and selective arteriography confirmed an 80% stenosis at the ostium of the left subclavian artery with slow flow into the left internal mammary graft to the left anterior descending artery. Since the anterior wall ischemia was presumed to be secondary to subclavian artery stenosis and flow reduction in the bypass graft, a decision was made to intervene on the left subclavian artery as the culprit lesion. A 7 French 90 cm Shuttle sheath used to cannulate the vessel and the lesion crossed using a 0.035 inch 180 cm Aquatrack wire. Balloon angioplasty was performed using a 5×40 mm Powerflex balloon with 1 inflation at 15 atmospheres. An iCAST 7×38 mm CS was deployed with 1 inflation at 12 atmospheres followed by post-dilatation using a 8×20 mm Powerflex balloon with 1 inflation at 10 atmospheres with a good angiographic result (Fig. 3b) and no residual gradient. The patient was discharged home in a stable condition the following day.

Discussion

CS have the ability to exclude plaque and endothelium, thereby offering the potential of mitigating late luminal loss by halting migration and proliferation of cells through open stent struts [3]. However, the role of CS in occlusive disease has been limited due to size of the delivery system, bulk of the graft material, and lack of precision due to foreshortening from the self-expanding design [1]. Additional limitations to the use of CS involve the risk of excluding adjacent side-branches, specifically the vertebral and internal mammary arteries and right common carotid artery with subclavian CS. Moreover, the risk of embolization to these vital side-branches despite the use of CS, may warrant the use of additional embolization protection devices as deemed necessary based on flow patterns in these arteries. Recent advances in CS design with development of a laser cut stainless steel balloon expandable stent with an encapsulated outer cover of expanded polytetrafluoroethylene (PTFE) have been promising in aortoiliac occlusive disease [4] and complex endovascular pathology [1]. The iCAST CS used in these cases are a unique low-profile design with microporous PTFE film covering the entire surface of the balloon expandable stainless steel struts and thereby protecting the metal from contact with lumen, minimizing trauma to the supporting vessel wall, and preventing prolapse of tissue through the stent. The cases presented herein demonstrate the successful treatment of subclavian artery stenosis with CS. However, the long-term results of patency and late luminal loss remain to be evaluated in future randomized studies.

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